

## CLAIMS:

1. A device for measuring tone reproduction characteristics, which indicate a relationship between input signal tone values and actual display  
 5 luminance of a color monitor (100) having a function of displaying color images using three primary colors of R, G, and B, the tone reproduction characteristics measuring device for color monitor comprising:

tone value designating means (210), designating a combination of tone values of the three primary colors, R, G, and B, for displaying an even  
 10 pattern of uniform brightness and color in a first attribute region (50);

reference pattern generating means (220) generating a reference pattern in which first sub-regions (61) and second sub-regions (62) are mixed at a prescribed area ratio inside a second attribute region (60), wherein each of the three primary colors, R, G, and B take on a minimum  
 15 tone value in said first sub-regions and each of the three primary colors, R, G, and B take on a maximum tone value in said second sub-regions;

pattern display means (230) defining a test pattern which is arranged from said first attribute region and said second attribute region being positioned so as to contact each other on a screen of the color monitor,  
 20 and providing prescribed signals to the color monitor so that an even pattern, based on the combination of tone values designated by said tone value designating means, is displayed in said first attribute region, and said reference pattern, generated by said reference pattern generating means, is displayed in said second attribute region;

25 tone value varying means (240) varying respective tone values designated by said tone value designating means so as to vary a brightness and a color of the even pattern;

coincidence signal input means (250) inputting, while a varying operation by said tone value varying means is being performed, a  
 30 coincidence signal indicating a recognition that said first attribute region and said second attribute region are matched in both brightness and color, from an operator who views said test pattern displayed on the screen of the color monitor; and

characteristics computing means (260) recognizing a combination of  
 35 tone values designated by said tone value designating means at a point when said coincidence signal is input, as corresponding tone values of the

respective primary colors that correspond to a prescribed reference luminance in accordance with said prescribed area ratio, and determining, by computation, tone reproduction characteristics of the respective primary colors based on said reference luminance and said corresponding tone values  
5 that correspond to each other.

2. The tone reproduction characteristics measuring device for color monitor according to Claim 1, wherein:

the tone value varying means (240) has a function of performing two  
10 types of varying operations of a brightness varying operation, with which the tone values are varied so that mainly a brightness of the even pattern changes, and a color varying operation, with which a tone value is varied so that mainly a color of the even pattern changes.

15 3. The tone reproduction characteristics measuring device for color monitor according to Claim 2, wherein:

the brightness varying operation is performed by a task of increasing or decreasing all of respective tone values of the three primary colors, R, G, and B by a common variation amount, and

20 the color varying operation is performed by a task of increasing or decreasing a tone value of a single specific color among the three primary colors, R, G, and B.

4. The tone reproduction characteristics measuring device for color  
25 monitor according to any of Claims 1 through 3, wherein:

the tone value varying means (240) performs variations of the tone values based on operation inputs by the operator.

5. The tone reproduction characteristics measuring device for color  
30 monitor according to Claim 4, wherein:

the tone value varying means (240) uses a first button (31) that provides an instruction of making the even pattern brighter, a second button (32) that provides an instruction of making the even pattern darker, a third button (33) that provides an instruction of strengthening a  
35 component of a specific color of the even pattern, and a fourth button (34) that provides an instruction of weakening a component of the specific color

of the even pattern, and performs a varying operation of adding a common variation amount to all of the respective tone values of the three primary colors, R, G, and B, when there is an operation input in regard to the first button, performs a varying operation of subtracting a common variation amount from all of the respective tone values of the three primary colors, R, G, and B, when there is an operation input in regard to the second button, performs a varying operation of adding a prescribed variation amount to a tone value of the specific color when there is an operation input in regard to the third button, and performs a varying operation of subtracting a prescribed variation amount from a tone value of the specific color when there is an operation input in regard to the fourth button.

6. The tone reproduction characteristics measuring device for color monitor according to Claim 5, wherein:

a two-dimensional XY coordinate system is defined and the respective buttons are positioned so that the first button (31) and the second button (32) are positioned at opposing positions along an X-axis that sandwich an origin and the third button (33) and the fourth button (34) are positioned at opposing position along a Y-axis that sandwich the origin.

7. The tone reproduction characteristics measuring device for color monitor according to any of Claims 1 through 3, wherein:

the tone value varying means (240) varies the tone values with time in accordance with prescribed rules that have been established in advance.

8. The tone reproduction characteristics measuring device for color monitor according to Claim 7, wherein:

the tone value varying means (240) has a function of performing two varying operations of a brightness varying operation, wherein, by adding or subtracting a common variation amount at a prescribed timing to or from all of respective tone values of the three primary colors, R, G, and B, the tone values are varied so that mainly the brightness of the even pattern changes, and a color varying operation, wherein, by adding or subtracting a prescribed variation amount at a prescribed timing to or from a tone value of one specific color among the three primary colors, R, G, and B, the tone value is varied so that mainly the color of the even pattern changes, and

the coincidence signal input means (250) has a brightness coincidence signal input means, for inputting, while the tone value varying means is performing the brightness varying operation, a brightness coincidence signal that indicates a recognition that the brightness is matched from the operator, and a color coincidence signal input means, for inputting, while the tone value varying means is performing the color varying operation, a color coincidence signal that indicates a recognition that the color is matched from the operator, and deems that a coincidence signal indicating a recognition of matching of both brightness and color is input when both inputs of the brightness coincidence signal and the color coincidence signal are completed.

9. The tone reproduction characteristics measuring device for color monitor according to Claim 8, wherein:

when a tone value obtained by a varying operation of adding a variation amount exceeds a maximum tone value, a circulation process of incrementing a minimum tone value by an excess amount is performed, and when a tone value obtained by a varying operation of subtracting a variation amount falls below the minimum tone value, a circulation process of decrementing a maximum tone value by an excess amount is performed.

10. The tone reproduction characteristics measuring device for color monitor according to Claim 8 or 9, wherein:

the tone value varying means (240) has a function of starting the color varying operation at a point when the brightness coincidence signal is input while the brightness varying operation is performed, starting the brightness varying operation at a point when the color coincidence signal is input while the color varying operation is performed, and repeatedly executing the brightness varying operation and the color varying operation in alternation and has a function of performing a repeated execution while gradually decreasing the tone value variation amount, and

the coincidence signal input means (250) deems that the coincidence signal indicating a recognition of matching of both brightness and color is input when both inputs of the brightness coincidence signal and the color coincidence signal are completed after the variation amount has reached a predefined value.

11. The tone reproduction characteristics measuring device for color monitor according to any of Claims 3, 5, and 8, wherein:

5 of the three primary colors, R, G, and B, the primary color B is deemed to be the specific color and tone reproduction characteristics for the primary color B and tone reproduction characteristics in common to the primary colors R and G are determined.

10 12. The tone reproduction characteristics measuring device for color monitor according to any of Claims 1 through 11, wherein:

the reference pattern generating means (220) has a function of setting a plurality N of area ratios of the first sub-regions to the second sub-regions and generating N reference patterns that differ mutually in reference luminance, and

15 the characteristics computing means (260) has a function of determining the tone reproduction characteristics for the respective primary colors based on N corresponding tone values obtained for N test patterns using the N reference patterns.

20 13. The tone reproduction characteristics measuring device for color monitor according to Claim 12, wherein:

the characteristics computing means (260) defines a two-dimensional coordinate system in which a first coordinate axis is set for tone value and a second coordinate axis is set for luminance, plots N points having respective  
25 luminance values and corresponding tone values as coordinate values on the coordinate system, plots a point having a minimum luminance value and a minimum tone value as coordinate values, and a point having a maximum luminance value and a maximum tone value as coordinate values, and determines a curve passing through the total of (N + 2) plotted points in a  
30 form of a graph that indicates the tone reproduction characteristics.

14. The tone reproduction characteristics measuring device for color monitor according to Claim 13, wherein:

35 N is set equal to 3, a total of five points are plotted, and upon referring to these five points as a first point to a fifth point in the order of increasing coordinate value along the first coordinate axis, a first function

curve, passing through the first, second, and third points and taking a form of expressing the luminance as a power of the tone value, and a second function curve, passing through the third, fourth, and fifth points and taking a form of expressing the luminance as a power of the tone value are determined by computation, and a curve formed by joining the first function curve and the second function curve is deemed to be the curve expressing the tone reproduction characteristics.

15. The tone reproduction characteristics measuring device for color monitor according to any of Claims 1 through 14, wherein:

the reference pattern generating means (220) forms the first sub-regions and the second sub-regions from unit cells having the same shape and size and forms the reference pattern from a two-dimensional array of these unit cells.

16. The tone reproduction characteristics measuring device for color monitor according to Claim 15, wherein:

the reference pattern is formed by arraying rectangular unit cells in a two-dimensional array, and for arbitrary odd numbers  $i$  and  $j$ , a cell group, formed of four unit cells of a unit cell of an  $i$ -th row and a  $j$ -th column, a unit cell of the  $i$ -th row and a  $(j+1)$ -th column, a unit cell of an  $(i+1)$ -th row and the  $j$ -th column, and a unit cell of the  $(i+1)$ -th row and the  $(j+1)$ -th column, is defined, and a common positioning pattern of the first sub-regions and the second sub-regions is applied for all cell groups.

17. The tone reproduction characteristics measuring device for color monitor according to Claim 16, wherein:

among the four unit cells which make up a cell group, first sub-regions are formed by a pair of unit cells adjacent diagonally and second sub-regions are formed by a remaining pair of unit cells so as to constitute a reference pattern with an area ratio of 1:1.

18. The tone reproduction characteristics measuring device for color monitor according to Claim 16, wherein:

among the four unit cells which make up a cell group, one unit cell constitutes one sub-region and remaining three unit cells constitute the

other sub-region so as to constitute a reference pattern with an area ratio of 3:1 or 1:3.

19. The tone reproduction characteristics measuring device for color monitor according to any of Claims 1 through 18, wherein:

a contour of the first attribute region or the second attribute region that makes up the test pattern is made of a circle or an ellipse.

20. The tone reproduction characteristics measuring device for color monitor according to any of Claims 1 through 19, wherein:

one attribute region that makes up the test pattern is made of a plurality of regions positioned in a dispersed manner and the other attribute region is made of a background portion thereof.

21. The tone reproduction characteristics measuring device for color monitor according to Claim 20, wherein:

a total area of the first attribute region is made equal to a total area of the second attribute region.

22. The tone reproduction characteristics measuring device for color monitor according to Claim 20 or 21, wherein:

a plurality of regions of the same attribute that are the same in shape and size are positioned dispersedly in a two-dimensional plane at a prescribed pitch so that a prescribed spatial frequency is obtained.

23. The tone reproduction characteristics measuring device for color monitor according to Claim 22, wherein:

a plurality of one-dimensional region arrays, in each of which a plurality of regions of the same attribute are positioned in a horizontal direction at a prescribed pitch  $P_x$ , are positioned in a vertical direction at a prescribed pitch  $P_y$  (where  $P_y = (\sqrt{3}) / 2 \cdot P_x$ ) and positioned so that among mutually adjacent one-dimensional region arrays, the phase is shifted by half a pitch.

24. The tone reproduction characteristics measuring device for color monitor according to Claim 22 or 23, wherein:

regions of the same attribute are positioned dispersedly at a prescribed pitch by which a spatial frequency that exhibits good sensitivity in regard to both brightness difference discrimination characteristics and color difference discrimination characteristics for the operator viewing the test pattern is obtained.

25. The tone reproduction characteristics measuring device for color monitor according to Claim 22 or 23, wherein:

a first pitch, by which a spatial frequency that exhibits good sensitivity in regard to brightness difference discrimination characteristics for the operator viewing the test pattern is obtained, and a second pitch, by which a spatial frequency that exhibits good sensitivity in regard to color difference discrimination characteristics for the operator viewing the test pattern is obtained, are set, and

the pattern display means (230) has a function of displaying a test pattern, formed by dispersedly positioning regions of the same attribute at the first pitch, when a brightness matching recognition task is performed by the operator, and displaying a test pattern, formed by dispersedly positioning regions of the same attribute at the second pitch, when a color matching recognition task is performed by the operator.

26. A program for making a computer function as the measuring device according to any of Claims 1 through 25 or a computer-readable recording medium in which the program is recorded.

27. A device for measuring tone reproduction characteristics, which indicate a relationship between input signal tone values and actual display luminance of a color monitor (100) having a function of displaying color images using three primary colors of R, G, and B, the tone reproduction characteristics measuring device for color monitor comprising:

tone reproduction characteristics storage means (410) storing provisional tone reproduction characteristics;

image data storage means (420) storing image data of a sample image to be used in measurement;

image display means (430) which assumes that the tone reproduction characteristics of the color monitor are to be the provisional tone



reproduction characteristics stored in the tone reproduction characteristics storage means, performs prescribed tone corrections on image data stored in the image data storage means so that the sample image will be displayed with correct tone reproduction on the color monitor, and provides corrected  
5 image data to the color monitor;

a physical output medium (520) obtained by outputting the sample image on a physical medium based on the image data stored in the image data storage means;

characteristics modifying means (440) receiving instruction inputs,  
10 for making a sample image (510) displayed on a screen (500) of the color monitor, and a sample image (530) displayed on the physical output medium (520), close in brightness and color, from an operator who visually compares the two images;

coincidence signal input means (450) inputting a coincidence signal,  
15 indicating a recognition that both of the images are matched both in brightness and color, from the operator; and

characteristics output means (460) outputting the provisional tone reproduction characteristics, stored in the tone reproduction characteristics storage means when the coincidence signal is input, as a formal tone  
20 reproduction characteristics of the color monitor.

28. The tone reproduction characteristics measuring device for color monitor according to Claim 27, wherein:

image data of a plurality M of sample images that differ in overall  
25 brightness are stored in the image data storage means (420) and M physical output media (520), respectively corresponding to the M sample images, are prepared; and

the characteristics modifying means (440), upon receiving an instruction input concerning an i-th sample image among the M sample  
30 images, performs modifications stressed on "a portion corresponding to a brightness of the i-th sample image" on the provisional tone reproduction characteristics stored in the tone reproduction characteristics storage means.

35 29. The tone reproduction characteristics measuring device for color monitor according to Claim 28, wherein:

the tone reproduction characteristics storage means (410) stores curves, respectively indicating relationships between tone value and luminance for the three primary colors, R, G, and B, in a form of graphs indicating the tone reproduction characteristics, and

5 the characteristics modifying means (440), upon receiving an instruction input concerning an i-th sample image, recognizes a point on a curve, having a representative tone value of the i-th sample image, as a control point, and after moving the control point in a prescribed direction in accordance with the instruction input, modifies the curve smoothly so that it  
10 passes through the control point after movement.

30. The tone reproduction characteristics measuring device for color monitor according to Claim 29, wherein:

15 a mode value or an average value of pixel values of all colors of individual pixels indicated by the image data stored in the image data storage means is used as a representative tone value of the sample image.

31. The tone reproduction characteristics measuring device for color monitor according to Claim 28, wherein:

20 the tone reproduction characteristics storage means (410) stores curves, respectively indicating relationships between tone value and luminance for the three primary colors, R, G, and B, in a form of graphs indicating the tone reproduction characteristics, and

25 the characteristics modifying means (440), upon receiving an instruction input concerning an i-th sample image, recognizes a point on a curve, having a representative luminance value of the i-th sample image, as a control point, and after moving the control point in a prescribed direction in accordance with the instruction input, modifies the curve smoothly so that it passes through the control point after movement.

30 32. The tone reproduction characteristics measuring device for color monitor according to Claim 31, wherein:

35 a mode value or an average value of pixel values of all colors of individual pixels indicated by the image data stored in the image data storage means is determined as the representative tone value of the sample image, and a value converted by a prescribed conversion method based on

the determined representative tone value is used as the representative luminance value of the sample image.

33. The tone reproduction characteristics measuring device for color  
5 monitor according to Claim 31, wherein:

an actually measured value of luminance of an entire sample image on the physical output medium is used as the representative luminance value of the sample image.

10 34. The tone reproduction characteristics measuring device for color monitor according to Claim 27, wherein:

the characteristics modifying means (440) performs processes of varying the tone reproduction characteristics with time in accordance with prescribed rules that have been established in advance and performs  
15 modifications wherein provisional tone reproduction characteristics when an instruction input from the operator is provided are deemed to be new provisional tone reproduction characteristics.

20 35. The tone reproduction characteristics measuring device for color monitor according to Claim 34, wherein:

image data of a plurality M of sample images that differ in overall brightness are stored in the image data storage means (420) and M physical output media (520), respectively corresponding to the M sample images are prepared; and

25 the characteristics modifying means (440) has a function of executing processes of performing variations stressed on "a portion corresponding to a brightness of an i-th sample image among the M sample images" on the provisional tone reproduction characteristics stored in the tone reproduction characteristics storage means (410) for each of  $i = 1$  to M.

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36. The tone reproduction characteristics measuring device for color monitor according to Claim 35, wherein:

the tone reproduction characteristics storage means (410) stores curves, respectively indicating relationships between tone value and  
35 luminance for the three primary colors, R, G, and B, in a form of graphs indicating the tone reproduction characteristics, and

the characteristics modifying means (440), in executing a process of performing variations stressed on "a portion corresponding to a brightness of an i-th sample image," recognizes a point on each of the curves, having a representative tone value of the i-th sample image, as a control point, moves  
5 the control point in prescribed directions cyclically, and modifies the curve smoothly so that it passes through the control point after movement.

37. The tone reproduction characteristics measuring device for color monitor according to Claim 36, wherein:

10 a mode value or an average value of pixel values of all colors of individual pixels indicated by the image data stored in the image data storage means is used as the representative tone value of the sample image.

38. The tone reproduction characteristics measuring device for color  
15 monitor according to Claim 35, wherein:

the tone reproduction characteristics storage means (410) stores curves, respectively indicating relationships between tone value and luminance for the three primary colors, R, G, and B, in a form of graphs indicating the tone reproduction characteristics, and

20 the characteristics modifying means (440), in executing a process of performing variations stressed on "a portion corresponding to a brightness of an i-th sample image," recognizes a point on each of the curves, having a representative luminance value of the i-th sample image, as a control point, moves the control point in prescribed directions cyclically, and modifies the  
25 curve smoothly so that it passes through the control point after movement.

39. The tone reproduction characteristics measuring device for color monitor according to Claim 38, wherein:

a mode value or an average value of pixel values of all colors of  
30 individual pixels indicated by the image data stored in the image data storage means is determined as the representative tone value of the sample image, and a value converted by a prescribed conversion method based on the determined representative tone value is used as the representative luminance value of the sample image.

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40. The tone reproduction characteristics measuring device for color

monitor according to Claim 38, wherein:

an actually measured value of luminance of an entire sample image on the physical output medium is used as the representative luminance value of the sample image.

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41. The tone reproduction characteristics measuring device for color monitor according to any of Claims 27 through 40, wherein:

the characteristics modifying means (440) has a function of performing two types of modifying operations of a brightness modifying operation of modifying the tone reproduction characteristics based on an instruction input for mainly changing the brightness of the sample image displayed on a screen of the color monitor, and a color modifying operation of modifying the tone reproduction characteristics based on an instruction input for mainly changing the color.

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42. The tone reproduction characteristics measuring device for color monitor according to Claim 41, wherein:

the tone reproduction characteristics storage means (410) stores curves, respectively indicating relationships between tone value and luminance for the three primary colors, R, G, and B, in a form of graphs indicating the tone reproduction characteristics, and

the characteristics modifying means (440), performs modification on all of the respective curves of the three primary colors R, G, and B in performing the brightness modifying operation, and performs modification on only a curve of a color to be modified in performing the color modifying operation.

43. The tone reproduction characteristics measuring device for color monitor according to any of Claims 27 to 42, wherein:

an image, which can be recognized as a substantially achromatic image when viewed by the operator, is used as the sample image.

44. A program for making a computer function as the tone reproduction characteristics storage means, image data storage means, image display means, characteristics varying means, coincidence signal input means, and characteristics output means in the measuring device according to any of

Claims 27 through 43 or a computer-readable recording medium in which the program is recorded.

45. A device for measuring tone reproduction characteristics, which  
5 indicate a relationship between input signal tone values and actual display luminance of a color monitor having a function of displaying color images using three primary colors of R, G, and B, the tone reproduction characteristics measuring device for color monitor comprising:

10 means for determining a correspondence between luminance and tone value by visual recognition;

means for determining a combination of tone values of the three primary colors that appears to be achromatic; and

15 characteristics computing means determining, by computation, the tone reproduction characteristics for the respective primary colors from the correspondence between luminance and tone value and a combination of the three primary colors.